Economic and environmental performance of ecological dairy farming systems in Austria

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***Abstract* - we assess the performance of a range of ecological farming systems, going beyond a comparison of only conventional and organic farms, using a FADN sample of specialized dairy farms in Austria. We identify four different farming systems in our sample (standard farming, integrated/circular farming, organic farming and a combination of integrated/circular and organic farming), using a novel classification system, the LIFT farm typology. Performance comparisons are carried out based on partial performance indicators and efficiency analyses with Data Envelopment Analysis (DEA). We further control for sample selection bias with matching. Our results reveal potential synergies and trade-offs in terms of economic and environmental performance of the identified farming systems and of switching to a more ecological farming system.**

INTRODUCTION

In light of increasing environmental ambitions of the European Union and an associated ecological transition of its farming sector, it is crucial to assess how such a transition, besides potential environmental benefits, affects the economic viability of farms.

While a greater number of studies has investigated differences in economic and/or environmental performance based on well-established ecological classifications such as conventional and organic farming systems (Lakner and Breustedt, 2017), a broader comparison of a variety of ecological farming systems is less common, in particular with a typology that is applicable on a European scale with readily available data (Rega et al., 2021).

The aim of the present study is thus to assess performance of a broader range of ecological dairy farming systems in Austria, going beyond a comparison of only conventional and organic farms.

METHOD AND DATA

Our methodological approach consists of three steps: (i) identification of different ecological farming systems, (ii) calculation of performance indicators and (iii) comparison of performance.

We identify different ecological farming systems, using the LIFT farm typology (Rega et al. 2021). It allows to identify the following farming systems based on several indicators derived from FADN data: (i) low input farms are characterized by a lower level of use of environmentally detrimental inputs, (ii) integrated/circular farms are characterized by a higher degree of circularity in their input use (e.g. own feed) and organic farms, are farms that are either partially or fully certified as organic. Combinations of these farming system are also possibly. Farms which are not classified to any of these groups form a residual group, referred to as standard farming. Farms in this group do not stand out in any of the above described ecological criteria.

In terms of economic performance, we investigate indicators related to profitability (revenue cost ratios (RCR) including and excluding public payments as well as opportunity costs of own production factors land, labour and capital) and average products (AP) of individual inputs (i.e. monetary output divided by the respective input). With respect to environmental performance indicators, FADN data only provides limited information. We thus mainly use intensities of selected inputs as well as environmental subsidies as proxies for negative and positive environmental externalities from farming, respectively. In order to also assess overall efficiency, we employ an output-orientated Data Envelopment Analysis (DEA), assuming variable returns to scale.

We further control for structural differences between groups (e.g. due to site conditions or farm size) with matching. Specifically, we use direct covariate matching (DCM), which is a non-parametric, straight-forward and flexible matching approach and has been applied in similar contexts (Kirchweger et al., 2016). After matching, inference in terms of comparison of farm performance between groups is made by computing average treatment effects. Specifically, we calculate the average treatment effect on the treated (ATT).

Our FADN dataset consists of a pooled unbalanced panel of specialized dairy farms (TF14 = 45) with 796 farms in 2014 and 787 farms in 2015. We control for price differences between the years using price indices from Eurostat.

For the definition of a production technology in DEA, we use five inputs land (ha), labour (annual working units - AWU), capital (Euro), intermediate expenses (Euro) and herd size (livestock units - LSU). Further, we use three different output specifications, resulting in three different DEA models. In model one output consists of the overall market revenues, in model two we use two outputs, namely produced milk in kg and other output in Euro. In model three we use the sum of market revenues and agri-environmental as well as organic farming payments as one aggregated output (Renner, 2021).

PRELIMINARY RESULTS

Within our sample we identified 871 standard farms, 274 integrated/circular farms, 258 organic farms and 180 farms combining integrated/circular and organic farming. We considered farm size (measured by standard output), site conditions (proxied by LFA payments per LSU and the share of permanent grassland) and a dummy for the year 2014 (matched farms had to be from the same year) as matching variables. Farming systems differed significantly according to these indicators before matching, but these differences were eliminated through matching. At the same time, the number of matched farms is lower than the number of treated farms for each of the three treatments. Table 1 shows the ATTs of performance indicators after matching.

The effects of an uptake of ecological farming systems on profitability is mostly positive. However, if public payments are excluded and opportunity costs of own production factors are included, the effect becomes negative for integrated/circular farms and roughly 0 for the other two farming systems. For productivity, we largely observe negative ATTs of APs of land, labour, capital and livestock, whereas the ATTs are positive for the AP of intermediate expenses. Efficiencies of model 1 are rather similar, whereas negative ATTs are observed for efficiencies of model 2 for organic and organic + integrated/circular farms. The first three environmental indicators show mostly negative ATTs, meaning ecological farming systems have lower livestock densities, lower veterinary expenses and concentrate feed expenses. In turn environmental subsidies as well as efficiencies from model 3 show predominantly statistically significant positive ATTs.

Table 1. Average treatment effects on the treated (ATT) based on selected performance indicators, where treatment refers to the uptake of an ecological farming system.

Indicator	Stand. → integrated/ circular (n=76)	Stand. → organic (n=103)	Stand. → integrated/ circular + organic (n=60)
Economic performance			
Pu. RCR no opp. costs	0.20***	0.12***	0.37***
Pr. RCR no opp. costs	0.11***	0.04*	0.18***
Pr. RCR opp costs	-0.03***	0.00	0.00
AP of land	-1,046***	-555***	-1,745***
AP of labour	-6,962***	-253	-1,744.
AP of capital	-0.03***	-0.01.	-0.02***
AP of int. exp.	0.24***	0.10***	0.38***
AP of livestock	-243***	-45	-117*
Efficiency (model 1)	0.00	0.01	0.02***
Efficiency (model 2	-0.03	-0.07***	-0.07***
Environmental performance			
St. density (LSU/ha)	-0.31***	-0.21***	-0.63***
Vet exp./cow	-39***	-33***	-67***
Conc. feed exp./LSU	-201***	-11	-285***
RD subs./ha (excl. LFA and Inv.)	66***	158***	254***
Efficiency (model 3)	0.00	0.03***	0.07***

Note: ***, **, * and . indicate significance at the 0.1%, 1%, 5% and 10% level, respectively. n refers to the number of matched farms. RCR = revenue cost ratio; AP = Average Product; RD = rural development; LFA = less favoured areas

DISCUSSION AND OUTLOOK

Our matching results indicate that the identified farming systems differ based on the matching covariates, but that these differences can be eliminated by matching. In terms of performance, our results reveal potential synergies and trade-offs in economic and environmental performance of the identified farming systems and of switching to a more ecological farming system. Both integrated/circular farming systems can be seen as more extensive forms of dairy farming, compared to standard farming and organic farming. However, the non-organic integrated/circular farming system performs worse compared to the other groups. In contrast, organic and integrated/circular organic farms can compete with standard farms in terms of profitability, especially, if subsidies are included, a result which is not always found in similar literature (Mayen et al., 2010). At the same time, these farming systems also perform better in terms of environmental performance than the standard and integrated/circular farming system.

In a next step we will extend our analysis by testing further matching approaches, since the current reduction of treated observations after matching may lead to attrition bias. Also, we will consider potentially different production technologies of the identified farming systems and will analyse drivers of efficiency with a second stage regression.

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REFERENCES

Kirchweger, S., Kantelhardt, J., Leisch, F. (2016). Impacts of the government-supported investments on the economic farm performance in Austria. *Agric. Econ. – Czech* 61(8): 343–355.

Lakner, S., Breustedt, G. (2017). Efficiency Analysis of Organic Farming Systems: A Review of Concepts, Topics, Results and Conclusions. *German Journal of Agricultural Economics* 66(2): 85–108.

Mayen, C. d., Balagtas, J. v., Alexander, C.E. (2010). Technology Adoption and Technical Efficiency: Organic and Conventional Dairy Farms in the United States. *American Journal of Agricultural Economics* 92(1): 181–195.

Rega, C., Thompson, B., D'Alberto, R., Niedermayr, A., Kantelhardt, J., Gouta, P., Konstantidelli, V., Tzouranami, I., Desjeux, Y., Latruffe, L., Billaudet, L., Paracchini, M.L., 2021. LIFT farm typology developed, tested and revised, and recommendations on data needs. EU H2020 project LIFT Low-Input Farming and Territories - Integrating knowledge for improving ecosystem based farming. Deliverable D1.4.

Renner, S., Sauer, J., El Benni, N. (2021). Why considering technological heterogeneity is important for evaluating farm performance? European Review of Agriculture Economics 48(2): 415-445.